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Counting the time lived, the time left or illness? Age, proximity to death, morbidity and prescribing expenditures

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ABSTRACT

The objective is to understand what really drives prescription expenditure at the end of life in order to inform future expenditure projections and service planning. To achieve this objective an empirical analysis of public medication expenditure on the older population (individuals $\geq$ 70 years of age) in Ireland ($n = 231{,}780$) was undertaken. A two part model is used to analysis the individual effects of age, proximity to death (PTD) and morbidity using individual patient-level data from administrative pharmacy records for 2006–2009 covering the population of community medication users. Decedents ($n = 14{,}084$) consistently use more medications and incur larger expenditures than similar survivors, especially in the last 6 months of life. The data show a positive and statistically significant impact of PTD on prescribing expenditures with minimal effect for age alone even accounting for patient morbidities. Nevertheless improved measures of morbidity are required to fully test the hypothesis that age and PTD are proxies for morbidity. The evidence presented refutes age as a driver of prescription expenditure and highlights the importance of accounting for mortality in future expenditure projections.

1. Introduction and background

Growth in healthcare expenditures and in particular, prescribing expenditures increases pressure on government budgets, healthcare providers and individuals. Understanding drivers of this growth should enable forecasting of more accurate future expenditures and inform appropriate policies to reduce expenditures.

Studies frequently associate ageing with higher health care costs relative to the younger population (Anderson and Hussey, 2000; Gregersen, 2014; Miller, 2001; Reinhardt, 2000; Westerhout, 2006). The elderly population is estimated to cost between 30% and 50% of total health care expenditure in OECD countries (Jacobzone, 2002). Anderson and Hussey (2000) examined health care expenditure and income across eight industrial countries and estimated that the average person aged 65 years or more costs between 2.7 and 4.8 times more than the average person aged 0–64 years.

In 2009 Ireland had a predominantly urban population of approximately 4.4 million of which 0.34 million (7.6%) were 70 years or older (CSO, 2013). Similar to other developed countries the Irish population over 70 years of age is predicted to almost double by 2031 along with increases in the age dependency ratio (CSO, 2013). Coinciding with the beginnings of this demographic shift Ireland has witnessed a large increase in public pharmaceutical expenditures with annual growth in real per capita expenditure on pharmaceuticals at 8.5% in the decade to 2009 (OECD average 3.5%) (OECD, 2011) and an economic recession beginning in 2008. At the time of this study those aged 70 years or older had access to free medications (A co-payment was introduced in 2010, this is currently €2.50 per item up to a maximum of €20 per family per month in 2016). The over 70s accounted for 49.6% of the annual public expenditure on prescription medication (Primary Care Reimbursement Service (PCRS), 2010).

While ageing is frequently associated with higher health care costs (Dormont et al., 2006) some commentators fail to acknowledge that part of these higher costs reflect the greater number of people close to death in this age group as well as age related health care needs. Individuals health care needs are higher as they approach death, with more than a quarter of all acute health care costs

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incurred in the last year of life (Polder et al., 2006; Wanless, 2002). However individuals in their last year of life may not necessarily be the oldest. There appears to be general consensus that PTD has an effect on healthcare expenditures in acute and long term health care (Comas-Herrera et al., 2007; McGrail et al., 2000; Payne et al., 2007; Seshamani and Gray, 2004b; Werblow et al., 2007; Zweifel et al., 1999). What is less known is the extent of the effect. Previous studies have focused on hospital or long term care expenditures with little separate analysis of medication expenditures. Wanless (2002) highlighted the need to consider all healthcare utilisation in relation to age, proximity to death and other factors.

The literature proposes three main possibilities on ageing and health, all assume increasing longevity, Gruenberg's (1977) “Failure of success” theory envisages the proportion of life spent in ill health increasing as longevity increases, an expansion of morbidity. In contrast to this Fries (1980) “compression of morbidity” theory proposes that people will live longer healthier lives with a limited period of illness at the end of life. A third possibility is put forward by Manton (1982), who found the other two theories inadequate to explain mortality trends in the USA. His hypothesis is of a “dynamic equilibrium” where morbidity increases due to rising levels of chronic conditions and disabilities amongst the older population while serious disability would decrease. Morbidity would seem an important component of any examination of PTD, although disentangling the two in the last years of life may not be possible.

While attempts have been made to predict future expenditure on prescriptions (Bennett et al., 2009) there currently appears to be few studies on the impact of ageing on future drug expenditure taking proximity to death into account (Kildemoes et al., 2006; Seshamani and Gray, 2004c). The aim of this study is to examine the importance of proximity to death, ageing and morbidity for public expenditure on prescription medication and report the implications for expenditure projections. Given the rising volume and costs of prescribing experienced in developed countries, gaining an understanding of what effects health care expenditure in this area will assist policy makers to more accurately predict and develop new policies to control future spending on prescription drugs.

2. Data and methods

2.1. Data

Community prescribing for 2006–2009 inclusive and mortality data from 2009 to 2012 for individuals aged 70 years or more in the Republic of Ireland were extracted from the Health Service Executive Primary Care Reimbursement Service (HSE-PCRS). This time period was used to guarantee a full 36 months of observations for decedents and to ensure the comparison survivors are not in their last three years of life. The prescription dispensing data contain records of all medications dispensed to individuals in the community. It does not include medicines that are only prescribed in hospital, such as chemotherapy agents but it does include medications which may be initiated in hospital but continued in the community such as anti-rejection drugs for transplant patients, immunostimulants, medicines used in conjunction with chemotherapy or hormonal therapy. The following variables were extracted: a unique person identifier; date of birth; region, gender; age; date of claim; details of medication dispensed and ingredient cost. The ingredient cost is the ex-factory price plus the wholesale mark-up and is the price negotiated for all regions between the state health agency (The Health Service Executive HSE) and manufacturers. Ingredient cost is the amount reimbursed to pharmacists for medications dispensed but does not include a dispensing fee which varies based on overall quantities dispensed by an individual pharmacy, the time of day and nature of the medication. The linked mortality records include a unique person identifier and the date of death. Unlike previous studies examining Health Care Expenditure (HCE) which employed samples, the time period of this study has been selected to facilitate the use of a national cohort.

In order to gain an insight into the differences between decedents and survivors a matched case-control study methodology was used. Decedents (cases) aged at least 72 years at the start of 2009 were selected to ensure they had access to free medication for the duration of the expenditure study 2006–2009, and were matched 1:1 based on age, gender and region to survivors (controls). Previous research has suggested that there may be regional and gender variances in health service use (Conway et al., 2014; Wren, 2011). Appendix Fig. A1 shows a participant flowchart. [INSERT LINK TO ONLINE APPENDIX] Controls (survivors) are those individuals who were in receipt of medication in 2009 and who did not die in the subsequent three years (2010–2012). A descriptive analysis of the monthly expenditures of both cases and controls was undertaken and the mean monthly expenditures and medication usage of survivors and decedents were compared.

To provide more detailed information regarding the health and social circumstances of the community dwelling population aged 70 or more which was not available from prescribing records data from the Irish Longitudinal Study of Ageing (TILDA) was used. The first wave of TILDA provides a cross section of nationally representative health, social and economic data on the Irish population aged 50 years or more ($n = 8174$) with 2307 participants aged 70 or more in 2009/2010 and its methodology is described in detail elsewhere (Kenny et al., 2010; Barrett et al., 2011). All prevalence results from TILDA were weighted using age, sex and educational attainment to be representative of the total population using the 2011 Census.

In addition a number of population scenarios from the Central Statistics Office (CSO) online database Statbank (CSO, 2013) were used, based on the 2011 Census population figures, to estimate future population taking births, deaths and migration into account (see Appendix for a brief description). All analysis were conducted using Stata version 12 (Stata Corp., College Station, Texas). Ethical approval was received for this study from the Health Policy and Management Research Ethics Committee, Trinity College Dublin.

2.2. Model specification

The primary outcome was monthly individual expenditure on community prescription medication for a 36 month period ending in 2009 (month of death in 2009 or matched month for survivors), which is highly skewed with non-constant variance and a large number of zeros. Methods employed must account for the skewed distribution of the data and the large numbers of zeros (zero-inflation) (Blough and Ramsey, 2000; Manning and Mullahy, 2001). Based on the literature examining expenditure data a two part model (TPM) using a Probit and generalized linear model (GLM) was considered appropriate. The Probit was used to identify those who had any expenditure and the GLM to model those positive expenditures. The following Probit model was run to examine the effects of age, gender, proximity to death and region on the probability of using medication in a given month.

$$\Pr(Expend. > 0) = \propto + \beta_1 A + \beta_2 A^2 + \beta_3 AG + \beta_4 G + \beta_5 D + \sum_{t=1}^{35} m_t M_t + \sum_{e=1}^{7} \varepsilon_e R + \sum_{t=1}^{35} \gamma_t M_t D$$

Where A: individual age; A^2: Age squared; AG: Age gender interaction; G: Male gender (1), Female (0); D: decedent (1); M: months until death or censor; R: Region; M_t D: decedent-month interaction term. To account for the nonlinearity of age an age squared variable was added.

The second part of the model is a random effects GLM which facilitates the analysis of mean costs while allowing for the non-normal distribution of the data and the longitudinal observations for each individual. The model consists of a distribution function for costs and a link function which describes the nature of the relationship of the covariates with the cost. The various GLMs were assessed using the modified Parks test following Manning and Mullahy (2001), Akaike Information Criteria (AIC) and normal probability plots of deviance residuals to ascertain a suitable distribution function. While there is no one test for assessing an appropriate link function the following three tests were run for guidance: Pearson correlation test; Pregibon link test; a modified Hosmer and Lemeshow test. The consistent result from these tests was gamma distribution function and a log link.

$$\mathrm{GLM(Exp\ )} = \propto + \beta_1 + \beta_2 A + \beta_3 A^2 + \beta_4 AG + \beta_5 G + \beta_6 D + \sum_{t=1}^{35} m_t M_t + \sum_{e=1}^{8} \varepsilon_e R_e + \sum_{t=1}^{35} \gamma_t M_t D$$

The use of a log link function in the GLM means the coefficients act multiplicatively on the mean, by taking the exponential they can be expressed as the percentage increase in the mean monthly medication expenditure per unit increase in the covariate (Barber and Thompson, 2004).

2.3. Chronic disease score

The pharmacy claims database lacks information on diagnosis, thus combinations of pharmaceutical therapies are used as proxies for broad medical conditions. This methodology lacks specificity for certain conditions as some medications may have a broad application across a number of conditions or even off label use. Despite this limitation the methodology has been validated in several settings (Fishman et al., 2003; Gray et al., 2000; Maio et al., 2005; Schneeweiss et al., 2002; Silwer and Lundborg, 2005) and previously used on Irish data (Naughton et al., 2006). The score was calculated following the methodology first employed by Von Korff et al. (1992). The index used is a pharmaceutical based comorbidity index, calculated from the sum of 20 potential chronic disease groups derived from dispensing data using Anatomical Therapeutic Chemical (ATC) codes (Appendix Table A1 lists the medications and ATC codes used). Individuals were assumed to have one of the diseases if they received at least three consecutive prescriptions of a medication representing a specific disease class in a 12 month period.

2.4. Projection models

Two projection methods were used: firstly traditional multiplicative models and secondly regression based projections, both of which are discussed in the following sections. Past mortality rates were used to project possible future trends (See Appendix Fig. A2).

2.4.1. Traditional models

Two traditional projection models of prescription cost estimation were used based on the current level of drug use continuing. Model 1, was calculated by assuming the rate of medication use remains constant at the 2009 level, applying age-sex specific prescribing rates and 2009 mean costs/individual to the total population. For each age group and sex we multiplied the mean expenditures by the projected population number to gain a total expenditure figure.

Model two in addition to model one includes proximity to death assuming the increasing mortality trend observed over the last decade will continue. This involves using mortality estimates detailed in Fig. A2 to project the number of decedents per year. Separate costs for decedents and survivors from the historical data analysis were used to calculate the total expenditure. These mortality projections were used with age-sex specific prescribing rates and costs/individual in 2009 for survivors and decedents.

2.4.2. Regression based models

Regression based predictions are calculated using the sum of the two part model outlined earlier, holding other variables at their mean values. Predicted cost in the two-part model:

$$\mathrm{E(Y|X)} = \mathrm{P(Y>0|X)} * \mathrm{E(Y|Y>0,X)}$$

Where P(Y>0|X) is the probability of any cost being incurred (Part 1) and E(Y|Y>0, X) is the predicted cost conditional on incurring any cost (Part 2). The last twelve months (1–12) were used in conjunction with population projections outlined in the previous section to calculate the projected expenditures.

3. Results

3.1. Descriptive statistics

The contextual data from TILDA shows that 92.2% (95% CI 91–93.3%) of those aged 70 or more had a medical card entitling them to free medications and the vast majority had only a primary education or none, 60.7% (95% CI 58.6–62.8%). The total population aged 70 years or more in 2006 that was used in the prescribing study and the population characteristics are set out in the Appendix Table A2. A total of 14,084 decedents or cases were matched to 14,084 survivors or controls with 65 cases not matched, due to the very small numbers of older people in certain regions. Those unmatched cases had a mean age of 99.3 years (Standard error (SE) 0.33yrs), a last year of life mean expenditure of €1715.9 (SE €172.2) and a median expenditure of €1361.6 (SE €168.2). In all time periods examined, 12, 24 or 36 months before death, decedents consistently show higher expenditures on medications than their counterparts who survived (see Fig. 1). The pattern changes in the last 12 months of life, during which decedents have a sustained month on month increase until death. Table 1 shows the decedent to survivor ratio for mean monthly expenditure in the last 12 months of life by gender and age group. The decedent to survivor ratios for the average number of items used shows a similar pattern 1.5 overall, 1.5 for females, 1.6 for males. (details of the expenditure amounts and means are contained in the Appendix, Tables A3 and A5) There is a declining ratio in number of items with age in females while males have a U shaped trend, bottoming in the 80–84 year old age group (Appendix Table A3). The higher expenditures of decedents are more evident in younger age groups and also persist as far out as three years before death. (Results for the full 36 months are shown in Appendix Tables A4 and A6).

3.2. Medication use

The median number of items per month was 4, mean of 5.6 (SE 0.002) and a range of 0–181. Table A1 in the appendix shows the prevalence of chronic conditions, based on the chronic disease score with 52.6% of the study population reporting 3 or more chronic diseases, rising to 72.2% for decedents. We see higher incidence of each chronic condition amongst decedents except for migraines, osteoporosis and rheumatological conditions. As expected chronic conditions are a significant driver of prescription expenditures, resulting in an average increase of 24% in expenditure per month for each additional condition. Dementia is

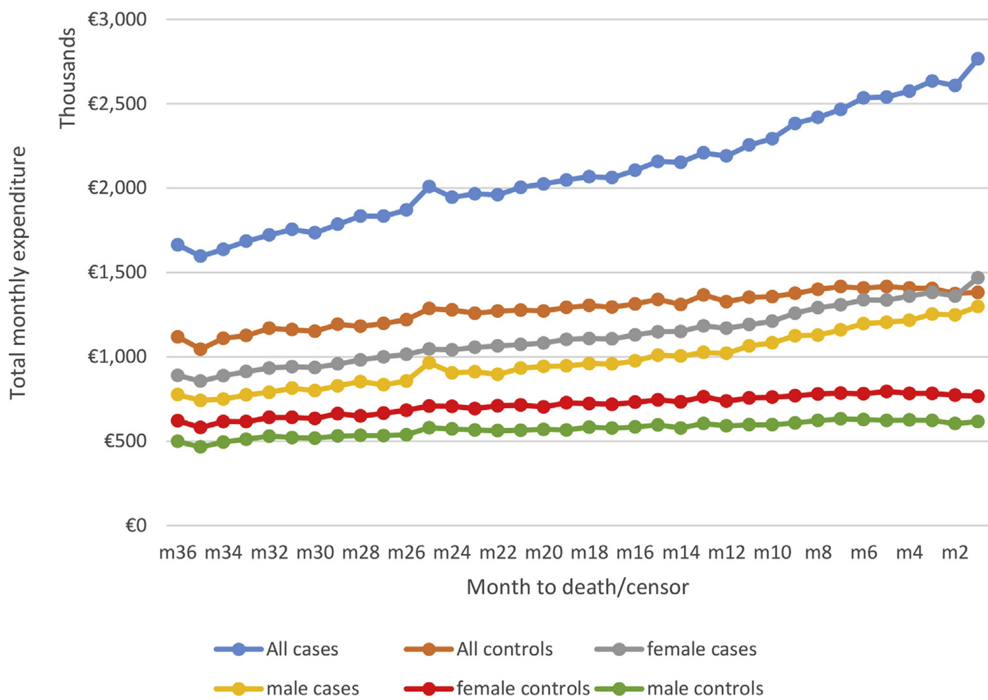

Fig. 1. Total monthly expenditures for matched cohort.

Table 1
Mean monthly expenditure ratio (decedents/ survivors) by age group and gender.

Gender	Age group	Mean expenditure ratio (Decedents /Survivors)
Both	All	1.8
female	All ages	1.7
	72–74	2.0
	75–79	1.9
	80–84	1.7
	85–89	1.5
	90+	1.6
male	All ages	1.9
	72–74	2.2
	75–79	1.9
	80–84	1.7
	85–89	1.9
	90+	2.0

Table A3 in Appendix reports the full detail of expenditures used to calculate the ratios.

responsible for the largest average increase in expenditure (78%). Acid related conditions, diabetes, epilepsy, hyperlipidemia, COPD and asthma are all associated with a 40% or more increase in average expenditures compared to those who don't have the conditions (results in Appendix Table A1).

3.3. Regression analysis

Table 2 sets out the summary results of a two part model for the full 3 year period, with the Probit showing the probability of expenditure on prescription medication and the GLM regression the effect on monthly expenditure per individual with the listed explanatory variables (full results in Appendix Table A7). An interaction term with decedent was included for each month to capture the proximity to death effect. Looking at the basic model in Table 2, age appears to have a neutral effect on expenditures, while decedents have on average 23.1% larger expenditures. An additional chronic condition increases monthly expenditures an average of 32.2%, taking the other variables contribution into account. Applying the regression model on only the last year before death shows both effects of being a decedent and having an additional chronic condition increase to 39.1% and 39.8% respectively (Results shown in appendix). Monthly expenditures for individuals who are dispensed a medication (part 2 of the model) show that decedents have consistently higher expenditure than survivors in the last 12 months of life. There is a marked increasing trend in the last 6 months of life, culminating in the last month with decedents having an expenditure that is 1.58 times more than survivors.

3.4. Expenditure projection

The traditional multiplier models are set out in the appendix for various population growth scenarios. In all cases not accounting for proximity to death in the models leads to significant overestimation of costs, ranging from 1.22 times to 1.73 times overestimated costs depending on the age group and demographics. In general there is less overestimation for older age groups. Table 3 shows the ratio of the model including PTD (model 1) to the model excluding (model 2). Full expenditures for each year and model are listed in Appendix Table A8.

Taking the ratio of excluding PTD to including PTD shows an overestimation of between 1.27 and 1.58 times depending on the age group and year (see Table 3). The models based on the predicted values display a similar pattern as the traditional models albeit with a slightly larger effect. The predicted expenditures for each year are displayed in the Appendix Table A9 for decedents and survivors.

4. Discussion

We investigated the effect of PTD, age and morbidity on historical community prescription expenditures and used this data to project future expenditures examining the effect of excluding PTD in their calculation. The analysis was carried out on a population administration dataset. Data from the Irish Longitudinal Study of

Table 2
Two part model using a Probit followed by a Generalized linear model (GLM) of monthly prescribing expenditures assuming a Gamma distribution with a log link.

Covariates	Probit				GLM on positive expenditures			
	Basic model[a]		Interactions model[b]		Basic model[a]		Interactions model[b]	
	Coeff.	Std. error	β	Std. error	Coeff.	Std. error	β	Std. error
Age	0.132ϕ	0.008	0.132ϕ	0.008	1.007	0.007	1.007	0.007
Age square	−0.001ϕ	4.7×10^{-4}	−0.001ϕ	0.000	1.000	4.7×10^{-5}	1.000	0.000
Male	1		1		1		1	
Female	0.023ϕ	0.003	0.023ϕ	0.003	0.916ϕ	0.003	0.916ϕ	0.003
No. Chronic conditions	−0.181ϕ	0.007	−0.471ϕ	0.013	1.231ϕ	0.008	1.152ϕ	0.014
Decedents	0.277ϕ	0.001	0.278ϕ	0.001	1.322ϕ	0.001	1.322ϕ	0.001
AIC					11.385		11.384	
Loglikelihood					−37,628,213		−37,625,078	

ϕ Indicates significance at the 99% level, respectively based on Z statistic.
Table A7 in Appendix reports the full detail of interactions and covariates used.
[a] Basic model includes dummy variables for 35 months prior to death/censor with month 36 as baseline and eight geographical regions with Midlands as the baseline.
[b] The interactions model additionally includes interactions between decedent and each month. Age and gender interactions where not significant univariately and not included in model.

Table 3
Ratio of Non PTD/ PTD (model 1/model 2) expenditures.

Model	Age (years)	2011	2016	2021	2026	2031
Traditional Model 1/2	70–74	1.52	1.53	1.53	1.54	1.54
Criteria: M3	75–79	1.41	1.41	1.42	1.43	1.44
Ratio: PTD/no PTD	80–84	1.29	1.30	1.31	1.32	1.33
	85 and over	1.22	1.22	1.23	1.24	1.25
Predicted values from Two-part regression model	70–74	1.56	1.57	1.58	1.58	1.58
	75–79	1.46	1.47	1.48	1.49	1.50
Criteria: M3	80–84	1.38	1.39	1.40	1.42	1.43
Ratio: PTD/no PTD	85 and over	1.27	1.28	1.29	1.30	1.32

Table A8 and A9 in Appendix report the full detail of expenditures used to calculate these ratios.

Ageing (TILDA) confirms that 92% of the population over 70 years had access to publically funded medications in 2009/2010. Those aged 70 or more account for 22.8% of the total number of individuals eligible for a medical card and 49.6% of the total prescription drug expenditures in 2009 (Authors calculations based on general medical card scheme data in (Primary Care Reimbursement Service (PCRS), 2010).

The results of this study show that decedents, on average, use more prescription medication and generate higher expenditures than survivors as distant as three years before death. The effect of PTD on prescription expenditures follows a similar trend to that of acute hospital expenditures only, but with a lower magnitude. Similar to acute hospital studies but in contrast to LTC studies age has minimal effect on expenditures. When we attempt to account for an individual's morbidities, PTD remains a predictor of prescribing expenditure. Projection analysis shows the importance of taking decedents into account when projecting future costs, failure to do so will lead to an overestimation of expenditures, regardless of demographic or projection model chosen. This overestimation is due to the higher expenditures of decedents increasing the total population mean. Overestimation of expenditure was previously reported in a Danish study but with a smaller effect (Kildemoes et al., 2006).

Similar to other studies we show a decline in the cost of dying with age (Garattini and van de Vooren, 2013; Geue et al., 2014; McGrail et al., 2000; Moore et al., 2014; Seshamani and Gray, 2004b) with those in the oldest group (≥90 years) costing on average 1.3 times less than those in the youngest age group (72–74 years in 2009). The reason to focus on the last year of life in projection models follows from evidence in this study and others that suggests this is when the PTD effect is the strongest (Smyth et al., 2013; van Baal and Wong, 2012).

The step like increases in expenditures for survivors correspond broadly with changes in pricing contracts between the state and the pharmaceutical industry. However Felder et al. (2010) posit that increasing medical technology may be responsible for increasing healthcare expenditure (HCE). This is also a plausible explanation for increasing pharmaceutical expenditures with high percentages of individuals on relatively expensive preventative medications introduced in the last decade and would explain the upward trend in survivor expenditures evidenced in the data. For example we know from TILDA data that 30.2% (95% CI: 29.1–31.2%) of the population over 50 regularly take a statin (Statins are a medication group used to lower cholesterol in the prevention of cardiovascular disease and at the time of this study were relatively expensive, 28 tablets of 10 mg Atorvastatin being €66) which rises to 41.6% (95% CI: 39.4–43.9%) of the population over 70 years and remains high in the over 80 s at 38.8% (95% CI: 34.4–43.1%).

De Meijer et al. (de Meijer et al., 2011) using an individual level Dutch dataset on LTC, found that once morbidity and disability were controlled for PTD becomes insignificant while age remains a driver of HCE. TILDA shows a prevalence of disability measured by Activities of Daily Living (ADL) or Instrumental Activities of Daily Living (IADL) impairment of 23% (95% CI 21.1–25%). With over a fifth of the population reporting a disability it makes it a plausible contender which may explain increased levels of expenditure. However we do not have individual level data on disability so we cannot examine how this effected survivors and decedents. While we did not control for disability, due to its absence from the prescribing dataset, we have included dummy variables for 20 chronic conditions, a chronic conditions count and based our study on community prescribing and still found a strong PTD effect. A flaw of this method is an individual needs to have been dispensed a medication for a condition before we can count it. They may have conditions they do not know about or have not been prescribed a medication for. The PTD effect that remains could be a proxy for some other unobserved morbidity for frailty, disability or senescence, all of which occur at different ages for different individuals (van Deursen, 2014). Without detailed data on disabilities or frailty and the absence of concrete biomarkers of senescence we cannot test any of these hypothesis.

The strength of this study lies in its use of a national population-based cohort of prescribing data that is automatically collected at the point of dispensing avoiding any recall or interview bias. We also use actual expenditure data rather than estimates used by other studies (Howdon and Rice, 2015; Seshamani and Gray, 2004a). A major limitation is the absence of linked morbidity and disability data. We used a chronic conditions index based on medications to try to overcome this limitation and discussed the general characteristics of the population based on data from a large cross-sectional study (TILDA). Similar to other studies we assumed no endogeneity between PTD and medication expenditure. The projections of future expenditure are based on observed patterns which are likely to change due to new and improved preventative and curative treatments, new pricing policies, patent expiries and the lifestyle changes of individuals.

5. Conclusion

The PTD effect is not just relevant for acute and LTC settings but is also evident in community prescribing expenditures. While the magnitude of the effect is lower than found in other settings it still has an important impact on future expenditure projections. We have shown that this effect is in part due to morbidity at the end of life. We attempted to control for numerous morbidities which demonstrated a reduction in the effect of PTD however we cannot concretely conclude that the PTD effect is a proxy for morbidity. We can conclude that based on the results age is not a driver of prescription expenditure in the population age 70 years or more. We need to obtain a greater understanding of what is driving this increased prescribing expenditure for decedents, both for health policy and for expenditure projections. Regardless of what age is a proxy for, failure to account for the large number of individuals who die in any year leads to an over estimation of the true expenditure and perpetuates the theory of ageing alone driving costs.

Even including separate estimates for decedent and survivor expenditures, as long as life expectancies increase there will be a rise in the demand for medications in an ageing population. This will be driven primarily by new products and the increasing prevalence of chronic conditions. To fully address this issue a more detailed dataset would be required. One that links prescribing data to health care diagnostic and outcome measures would provide more clarity on whether age is a proxy for proximity to death, morbidity, disability, senescence or a combination of all four. As people live longer with chronic conditions community based prescription medication will become even more prevalent. This study suggests that rather than focusing on ageing, policies aimed at controlling costs for medications to treat chronic conditions and at the end of life will help limit public expenditures.

Acknowledgements

Data were provided by the Primary Care Reimbursement Service (PCRS) of the Health Service Executive (HSE), Ireland, the Central Statistics Office (CSO), Ireland and the Irish Longitudinal Study on Ageing (TILDA).

Researchers interested in using TILDA data may access the data for free from the following sites:

Irish Social Science Data Archive (ISSDA) at University College Dublin http://www.ucd.ie/issda/data/tilda/

Interuniversity Consortium for Political and Social Research (ICPSR) at the University of Michigan http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34315.

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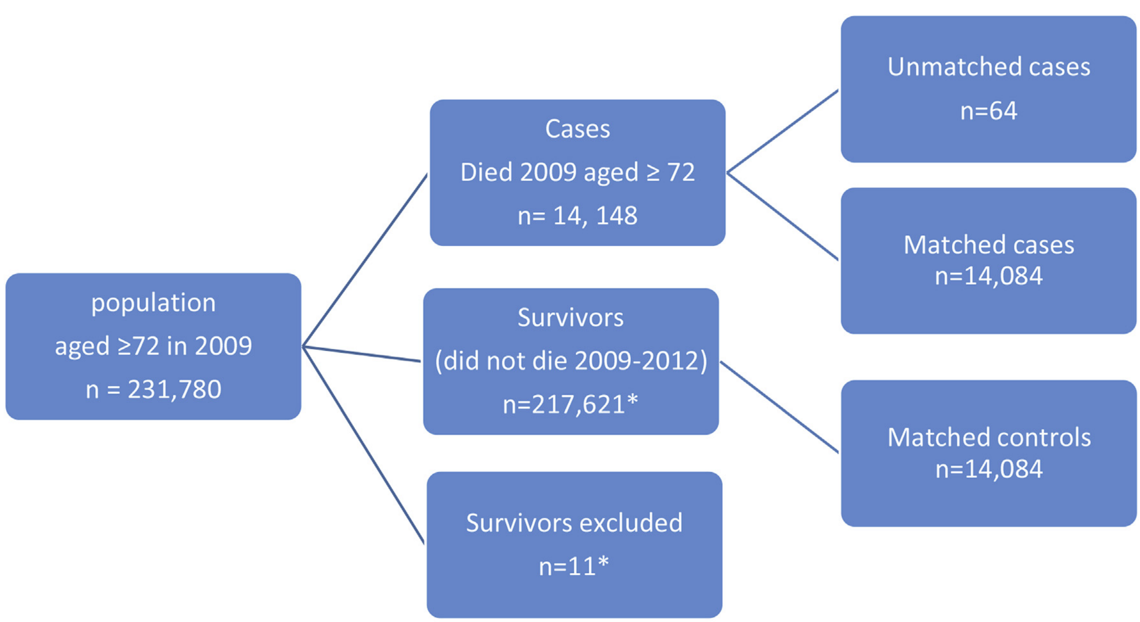
Appendix



*Five individuals were excluded due to incorrect date of birth recorded and six individuals due to errors in prescription records.

Fig. A1. Participant Flowchart.

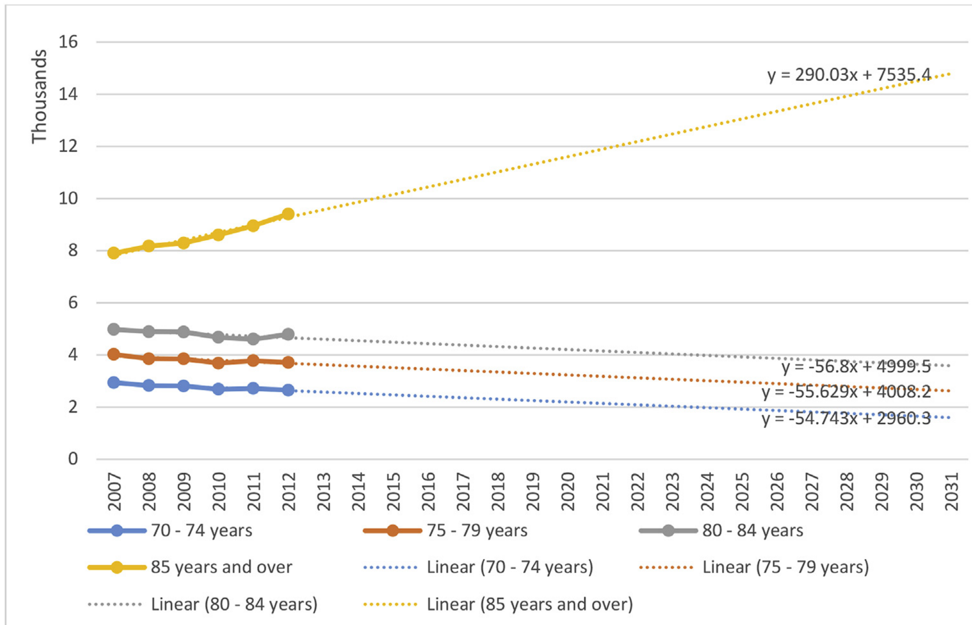


Fig. A2. Past mortality and future projections (in thousands of people). Based on Central Statistic Office (CSO) mortality data (Central Statistics Office, 2013).

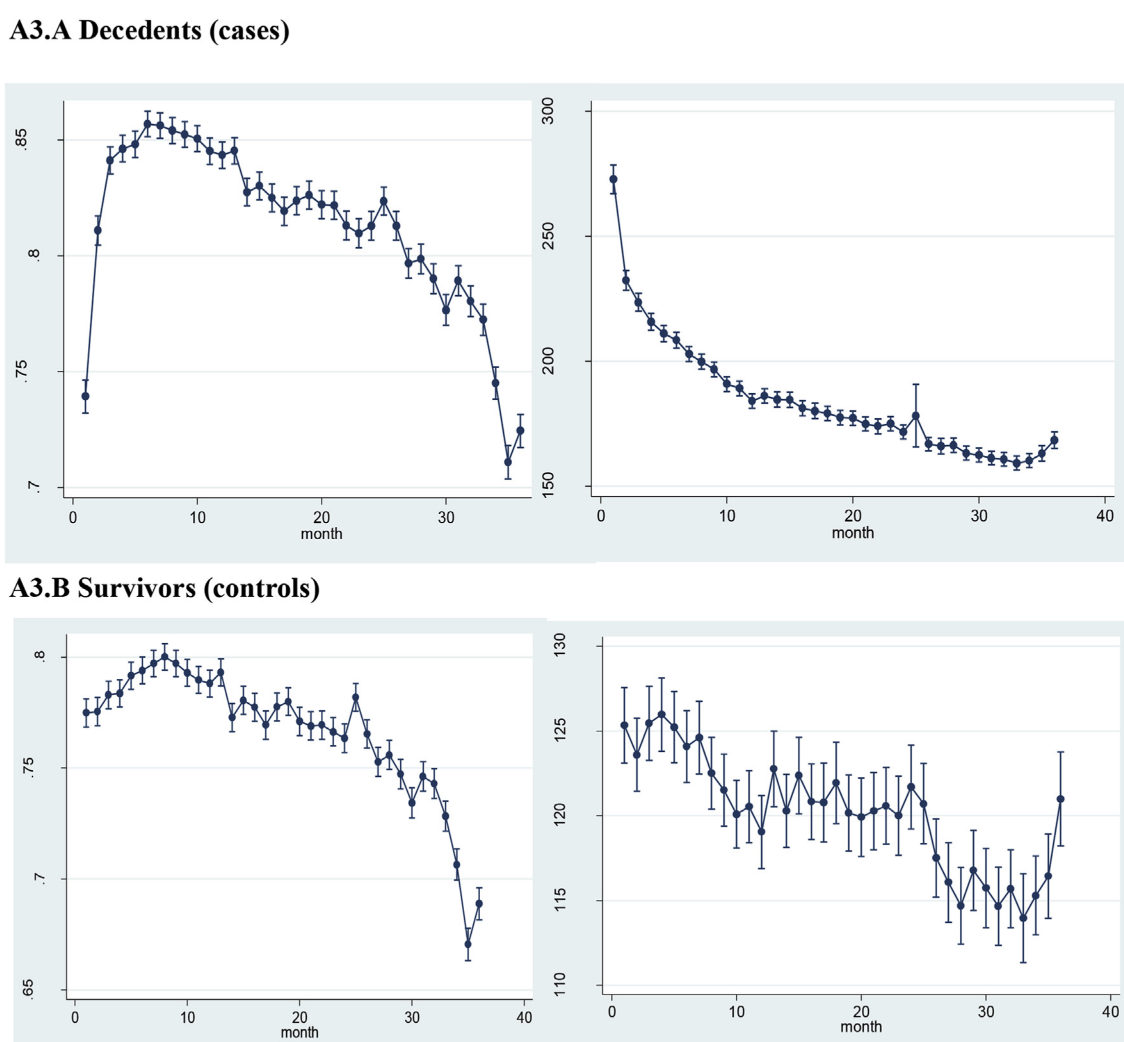


Fig. A3. Predicted probability of medication use and expenditure for decedents and matched survivors by month to death (95% confidence intervals).

Table A1
Chronic disease score – disease group composition

code	Chronic disease	Medications	ATC codes[a]	No. of population (%)	No. of decedents (%)	No. of survivors (%)
1	Acid related disorders	Drugs for acid related disorders	A02	87,545 (37.8)	8149 (57.9)	5346 (38.0)
2	Cancer	Antineoplastic agents	L01	624 (0.3)	79 (0.6)	41 (0.3)
3	Cardiovascular disease	Digitalis glycosides, Antiarrhythmics, Organic nitrates	C01	161,480 (69.7)	11,884 (84.4)	9699 (68.9)
		Antihypertensives	C02			
		Diuretics	C03			
		Beta blockers	C07			
		Calcium channel blockers	C08			
		Agents acting on the renin-angiotensin system - ACE inhibitors,	C09			
		Vitamin K antagonists	B01AA			
		Platelet aggregation inhibitors (excluding Heparin)	B01AC			
4	Dementia	Antidementia drugs	N06D	9400 (4.1)	1470 (10.4)	719 (5.1)
5	Diabetes mellitus	Insulins and analogs, Blood glucose lowering drugs, Other drugs used in diabetes	A10	22,332 (9.6)	1871 (13.3)	1205 (8.6)
6	Epilepsy	Antiepileptics	N03	12,920 (5.6)	1470 (10.4)	712 (5.1)
7	Glaucoma	Anti-Glaucoma and miotics	S01E	14,399 (6.2)	959 (6.8)	1050 (7.5)
8	Gout and hyperuricemia	Antigout preparations	M04A	7707 (3.3)	801 (5.7)	461 (3.3)
9	Human Immunodeficiency Virus (HIV)[b]	Protease inhibitors	J05AE	–	–	–
		Non-nucleoside reverse transcriptase inhibitors	J05AG			
		Antivirals for HIV	J05AR			
10	Hyperlipidemia	Lipid lowering agents	C10	106,585 (46)	5159 (36.6)	5598 (39.8)
11	Intestinal inflammatory disease	Intestinal inflammatory agents	A07E	1968 (0.9)	154 (1.1)	100 (0.7)
12	Iron deficiency anemia	Iron preparations	B03A	16,722 (7.2)	2449 (17.4)	1107 (7.9)
13	Migraines	Antimigraine preparations	N02C	321 (0.1)	14 (0.1)	12 (0.1)
14	Osteoporosis	Drugs for treatment of bone diseases	M05	34,263 (14.8)	2074 (14.7)	1890 (13.4)
15	Parkinson's disease	Anti-Parkinson's drugs	N04	5323 (2.3)	755 (5.4)	311 (2.2)
16	Psychiatric disorders	Antipsychotics	N05A	44,703 (19.3)	5350 (38.0)	2654 (18.9)
		Psychoanaleptics	N06A			
17	COPD & Asthma	Drugs for obstructive airways diseases	R03	35,309 (15.2)	4017 (28.5)	1986 (14.1)
18	Rheumatological conditions	Antirheumatic products	M01AB, M01AC, M01AE, M01AG, M01AH, M01AX, M01CB, M01CC, P01BA	41,721 (18.0)	2318 (16.5)	2273 (16.2)
19	Thyroid disorders	Thyroid therapy	H03	24,354 (10.5)	1611 (11.4)	1299 (9.2)
20	Tuberculosis[b]	Drugs for treatment of Tuberculosis	J04A	–	–	–

[a] All medications are described using WHO Anatomical Therapeutic Chemical (ATC) codes and names.
[b] There were no individuals with this condition.

Table A2
Population characteristics at baseline (2009).

	Total cohort population		2009 matched decedents		2009 matched survivors	
	N	%	N	%	N	%
Total	231,710	100.0	14,084	6.1	14,084	6.1
Female	136,215	58.8	7539	53.5	7539	53.5
Mean Age (SD)	79.1 years (5.5 years)		84.1 years (6.5 years)		84.1 years (6.5 years)	
Male	95,495	41.2	6545	46.5	6545	46.5
Mean Age (SD)	77.9 years (5.3 years)		81.6 years (5.9 years)		81.6 years (5.9 years)	
Age Groups						
72-74	63,120	27.2	1432	10.2	1432	10.2
75-79	82,158	35.5	3172	22.5	3172	22.5
80-84	51,973	22.4	3802	27.0	3802	27.0
85-89	25,120	10.8	3348	23.8	3348	23.8
90+	9339	4.0	2330	16.6	2330	16.6
Region						
Midlands	13,717	5.9	953	6.7	953	6.7
Mid-west	19,960	8.6	1433	10.2	1433	10.2
Northeast	19,851	8.6	1298	9.2	1298	9.2
Northwest	15,341	6.6	909	6.5	909	6.5
Southeast	28,324	12.2	1797	12.8	1797	12.8
South	36,936	15.9	2233	15.9	2233	15.9
West	27,033	11.7	1547	11.0	1547	11.0
East	70,548	30.5	3914	27.8	3914	27.8
Nr of chronic diseases						
0	26,284	11.3	744	5.3	1690	12.0
1	34,434	14.9	1114	7.9	2058	14.6
2	49,143	21.2	2065	14.7	3008	21.4
≥3	121,849	52.6	10,161	72.2	7328	52.0

Table A3
Ingredient costs for 12 months prior to death or censored (1:1 matching on age, gender, region) for 2008/2009, decedents from 2009.

		No. of individuals	Total annual expenditure (€)	Mean expenditure per individual (€)	Median expenditure per individual (€)	Mean no. of items per individual	Average expenditure per prescription (€) (total no. Items)
Decedents	All	14,084	29,667,717	2106.5	1722.0	107.5	19.6
	female	7539	15,671,269	2078.7	1688.9	108.9	19.1
	male	6545	13,996,448	2138.5	1761.0	105.8	20.2
Survivors	All	14,084	16,622,139	1180.2	888.7	70.3	16.8
	female	7539	9,262,681	1228.6	935.0	74.6	16.5
	male	6545	7,359,458	1124.4	838.8	65.3	17.2

Table A4
Ingredient costs for 36 months prior to death or censored (1:1 exact matching on age (as at 1st Jan 2009), gender, region) for 2006–2009, decedents from 2009.

		No. of individuals	Total expenditure (SE) (€)	Mean expenditure per individual (€)	Median expenditure per individual (€)	Mean no. of items per individual	Average expenditure per prescription (€)
Decedents	All	14,084	75,495,253	5360.4	4419.2	278.6	19.2
	female	7539	40,262,621	5340.6	4417.8	285.0	18.7
	male	6545	35,232,632	5383.1	4422.4	271.2	19.9
Survivors	All	14,084	46,152,395	3276.9	2513.2	195.1	16.8
	female	7539	25,632,571	3400.0	2635.2	206.6	16.5
	male	6545	20,519,823	3135.2	2385.3	181.8	17.2

Table A5
Ingredient costs for 12 months prior to death or censored (1:1 exact matching on age (as at 1st Jan 2009), gender, region), decedents from 2009 by age group and gender.

	Age group	Nr of individuals	Total expenditure (€)	Mean expenditure per individual (€)	Median expenditure per individual (€)	Mean nr of items per individual	Average expenditure per prescription (€)
Decedents female	70–74	576	1,328,240	2306.0	1760.0	107.7	21.4
	75–79	1415	3,329,458	2353.0	1940.6	112.5	20.9
	80–84	1944	4,260,201	2191.5	1797.8	114.1	19.2
	85–89	1953	3,956,046	2025.6	1687.5	110.0	18.4
	90+	1651	2,797,325	1694.3	1366.4	98.9	17.1
Decedents male	70–74	856	2,011,561	2350.0	1913.5	106.9	22.0
	75–79	1757	3,909,137	2224.9	1788.8	106.7	20.9
	80–84	1858	3,938,596	2119.8	1807.5	106.2	20.0
	85–89	1395	2,954,777	2118.1	1765.7	107.7	19.7
	90+	679	1,182,377	1741.4	1430.4	96.9	18.0
Survivors female	70–74	576	651,539	1131.1	808.2	63.6	17.8
	75–79	1415	1,749,202	1236.2	947.7	73.0	16.9
	80–84	1944	2,556,039	1314.8	1001.5	78.4	16.8
	85–89	1953	2,558,169	1309.9	995.5	79.6	16.4
	90+	1651	1,747,731	1058.6	771.1	69.3	15.3
Survivors male	70–74	856	933,319	1090.3	747.4	58.9	18.5
	75–79	1757	2,044,152	1163.4	880.9	64.7	18.0
	80–84	1858	2,261,722	1217.3	944.6	71.8	16.9
	85–89	1395	1,519,312	1089.1	827.9	65.9	16.5
	90+	679	600,952	885.1	603.9	55.8	15.8

Table A6
Ingredient costs for 36 months prior to death or censored (1:1 exact matching on age (as at 1st Jan 2009), gender, region), decedents from 2009 by age group and gender.

	Age group	No. of individuals	Total expenditure (€)	Mean expenditure per individual (€)	Median expenditure per individual (€)	Mean no. of items per individual	Average expenditure per prescription (€)
Decedents female	70–74	576	3,252,414	5646.6	4386.7	270.8	20.8
	75–79	1415	8,351,330	5902.0	4993.6	288.7	20.4
	80–84	1944	11,026,979	5672.3	4661.2	298.9	19.0
	85–89	1953	10,382,634	5316.2	4557.5	292.2	18.2
	90+	1651	7,249,264	4390.8	3666.6	261.9	16.8
Decedents male	70–74	856	4,783,902	5588.7	4526.6	259.2	21.6
	75–79	1757	9,826,965	5593.0	4556.1	270.9	20.6
	80–84	1858	10,080,810	5425.6	4598.9	278.3	19.5
	85–89	1395	7,568,999	5425.8	4447.0	280.8	19.3
	90+	680	2,971,955	4377.0	3618.3	247.8	17.7
Survivors female	70–74	576	1,796,448	3118.8	2196.9	175.1	17.8
	75–79	1415	4,808,147	3398.0	2595.8	201.1	16.9
	80–84	1944	6,971,411	3586.1	2795.5	215.0	16.7
	85–89	1953	7,125,596	3648.5	2880.3	220.8	16.5
	90+	1651	4,930,970	2986.7	2222.8	195.5	15.3
Survivors male	70–74	856	2,561,955	2992.9	2103.6	161.0	18.6
	75–79	1757	5,603,537	3189.3	2477.0	177.3	18.0
	80–84	1858	6,383,478	3435.7	2644.8	201.4	17.1
	85–89	1395	4,259,936	3053.7	2364.4	184.5	16.6
	90+	680	1,710,917	2519.8	1850.3	160.5	15.7

Table A7
Two part model using a Probit followed by a Generalized linear model (GLM) of monthly prescribing expenditures assuming a Gamma distribution with a log link, for 36 months.

Covariates	Probit				GLM on positive expenditures			
	Basic model		Interactions model		Basic model		Interactions model	
	Coeff.	SE	Coeff.	SE	Exp(Coeff.)	SE	Exp(Coeff.)	SE
Age	***0.132	0.008	***0.132	0.008	1.007	0.007	1.007	0.007
Age squared	***-0.001	4.7×10^{-4}	***-0.001	0.000	1.000	4.7×10^{-5}	1.000	0.000
Male	1		1		1		1	
Female	***0.023	0.003	***0.023	0.003	***0.916	0.003	***0.916	0.003
No. Chronic conditions	***-0.181	0.007	***-0.471	0.013	***1.231	0.008	***1.152	0.014
Decedents	***0.277	0.001	***0.278	0.001	***1.322	0.001	***1.322	0.001
Midlands	1		1		1		1	
Mid-west	***0.093	0.009	***0.093	0.009	***0.942	0.007	***0.942	0.007
Northeast	***0.042	0.009	***0.041	0.009	0.994	0.008	0.994	0.008
Northwest	0.013	0.010	0.012	0.010	***0.946	0.008	***0.946	0.008
Southeast	***0.051	0.009	***0.051	0.009	***0.930	0.007	***0.930	0.007
South	***0.076	0.008	***0.076	0.008	***0.943	0.006	***0.944	0.006
West	***0.076	0.008	***-0.063	0.008	***0.966	0.007	***0.966	0.007
East	***-0.060	0.008	***-0.060	0.008	***1.042	0.007	***1.042	0.007
1 month	***-0.662	0.004	***-0.708	0.004	***1.077	0.003	***1.034	0.003
2 months	***0.146	0.004	***0.133	0.004	***1.041	0.003	***1.020	0.003
3 months	***0.089	0.004	***0.064	0.004	***0.984	0.003	***0.963	0.003
4 months	***0.164	0.004	***0.142	0.004	***1.027	0.003	***1.011	0.003
5 months	***-0.027	0.004	***-0.059	0.004	***0.991	0.003	***0.974	0.003
6 months	***0.220	0.004	***0.199	0.004	***1.064	0.003	***1.053	0.003
7 months	***0.200	0.004	***0.178	0.004	***1.073	0.003	***1.066	0.003
8 months	***0.189	0.004	***0.167	0.004	***1.079	0.003	***1.073	0.003
9 months	***0.170	0.004	***0.147	0.004	***1.057	0.003	***1.050	0.003
10 months	***0.143	0.004	***0.119	0.004	***1.024	0.003	***1.017	0.003
11 months	***0.314	0.004	***0.302	0.004	***1.110	0.003	***1.110	0.003
12 months	***-0.407	0.004	***-0.457	0.004	***1.061	0.003	***1.060	0.003
13 months	***0.076	0.004	***0.050	0.004	***1.059	0.003	***1.057	0.003
14 months	***0.248	0.004	***0.238	0.004	***1.126	0.003	***1.128	0.003
15 months	***0.255	0.004	***0.244	0.004	***1.115	0.003	***1.116	0.003
16 months	***0.237	0.004	***0.226	0.004	***1.054	0.003	***1.053	0.003
17 months	***0.148	0.004	***0.133	0.004	***0.990	0.002	***0.985	0.002
18 months	***0.195	0.004	***0.182	0.004	***1.013	0.002	***1.010	0.003
19 months	***0.196	0.004	***0.183	0.004	***1.015	0.002	***1.013	0.002
20 months	***0.108	0.004	***0.089	0.004	***0.977	0.002	***0.973	0.002
21 months	***0.197	0.004	***0.185	0.004	***1.011	0.002	***1.009	0.002
22 months	***0.133	0.004	***0.119	0.004	***0.974	0.002	***0.970	0.002
23 months	***0.184	0.003	***0.174	0.004	***1.051	0.002	***1.052	0.003
24 months	***-0.761	0.004	***-0.824	0.004	***0.906	0.003	***0.898	0.003
25 months	***0.070	0.004	***0.049	0.004	***1.292	0.004	***1.307	0.003
26 months	***0.153	0.003	***0.141	0.003	***1.064	0.002	***1.068	0.003
27 months	***0.091	0.003	***0.078	0.003	1.003	0.002	*1.004	0.002
28 months	***0.099	0.003	***0.087	0.003	***1.014	0.002	***1.016	0.002
29 months	***0.079	0.003	***0.068	0.003	***1.007	0.002	***1.010	0.002
30 months	***0.071	0.003	***0.063	0.003	1.002	0.002	*1.004	0.002
31 months	***0.017	0.003	0.002	0.003	***0.964	0.002	***0.965	0.002
32 months	***0.060	0.003	***0.050	0.003	***0.990	0.002	***0.992	0.002
33 months	***0.056	0.003	***0.048	0.003	***0.983	0.002	***0.986	0.002
34 months	***-0.012	0.003	***-0.018	0.003	***0.959	0.002	***0.960	0.002
35 months	***0.018	0.003	***0.023	0.003	***1.007	0.002	***1.009	0.002
36 months	1		1		1		1	
Decedent*1 month			***0.761	0.018			***1.579	0.025
Decedent* 2 months			***0.190	0.018			***1.355	0.020
Decedent*3months			***0.392	0.018			***1.379	0.019
Decedent*4 months			***0.337	0.018			***1.266	0.017
Decedent*5months			***0.548	0.018			***1.286	0.018
Decedent*6months			***0.334	0.018			***1.172	0.016
Decedent*7months			***0.351	0.018			***1.126	0.015
Decedent*8 months			***0.352	0.018			***1.101	0.015
Decedent*9months			***0.362	0.018			***1.111	0.015
Decedent*10months			***0.382	0.018			***1.112	0.015
Decedent*11months			***0.173	0.017			1.007	0.013
Decedent*12 month			***0.924	0.017			**1.029	0.013
Decedent*13months			***0.424	0.017			***1.044	0.014
Decedent*14months			***0.155	0.017			**0.973	0.013
Decedent*15months			***0.161	0.016			0.981	0.012
Decedent*16months			***0.156	0.017			*1.024	0.013
Decedent*17months			***0.223	0.017			***1.090	0.014
Decedent*18months			***0.194	0.016			***1.052	0.013

(continued on next page)

Table A7 (*continued*)

Covariates	Probit				GLM on positive expenditures			
	Basic model		Interactions model		Basic model		Interactions model	
	Coeff.	SE	Coeff.	SE	Exp(Coeff.)	SE	Exp(Coeff.)	SE
Decedent*19months			***0.203	0.016			***1.043	0.013
Decedent*20months			***0.279	0.016			***1.080	0.013
Decedent*21months			***0.183	0.016			**1.030	0.013
Decedent*22months			***0.211	0.016			***1.064	0.013
Decedent*23months			***0.142	0.015			0.987	0.012
Decedent*24months			***1.154	0.016			***1.133	0.014
Decedent*25months			***0.326	0.015			***0.811	0.034
Decedent*26months			***0.189	0.015			***0.927	0.011
Decedent*27months			***0.185	0.015			*0.978	0.013
Decedent*28months			***0.184	0.014			**0.970	0.012
Decedent*29months			***0.169	0.015			***0.959	0.011
Decedent*30months			***0.122	0.015			***0.960	0.011
Decedent*31months			***0.231	0.015			0.991	0.012
Decedent*32months			***0.149	0.014			***0.961	0.011
Decedent*33months			***0.121	0.014			***0.957	0.011
Decedent*34months			***0.088	0.014			0.987	0.011
Decedent*35months			***-0.067	0.015			***0.950	0.012
Decedent*36months			1				1	
Constant			0.132	0.008	1.007	0.007	1.007	0.007
Akaike Information Criteria (AIC)					11.385		11.384	
Loglikelihood					−37,628,213		−37,625,078	
n	8,341,380		8,341,380		6,609,899		6,609,899	

Coefficient (Coeff.), exponential (exp), Standard error (SE).
*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.

Table A8
Expenditure projections for traditional multipliers model 1(non PTD) and model 2 (PTD).

Model	Age (years)	2011 (€)	2016 (€)	2021 (€)	2026 (€)	2031 (€)
Model 1 no PTD Criteria: M1	70–74	223,707,467	271,337,727	330,660,614	367,286,049	414,228,508
	75–79	176,330,327	195,284,968	243,280,205	300,665,815	337,531,721
	80–84	119,483,924	134,718,980	154,747,088	197,884,550	248,553,951
	85 and over	88,748,795	106,590,048	129,920,917	159,503,849	208,300,437
Model 2 PTD Criteria: M1	70–74	147,312,355	177,605,682	215,455,759	238,696,807	240,125,827
	75–79	125,358,156	138,028,925	170,721,661	209,872,187	212,688,641
	80–84	92,537,419	103,652,134	118,216,253	149,887,099	154,161,204
	85 and over	72,893,843	87,322,146	105,788,877	128,895,847	146,781,021
Model 1 no PTD Criteria: M2	70–74	223,707,467	271,165,777	329,456,962	364,706,793	409,757,797
	75–79	176,330,327	195,111,072	242,584,622	298,752,961	334,053,806
	80–84	119,483,924	134,547,800	154,233,547	196,857,468	246,328,605
	85 and over	88,748,795	106,590,048	129,615,938	158,741,402	206,623,054
Model 2 PTD Criteria: M2	70–74	147,312,355	177,495,008	214,681,038	237,036,690	265,700,787
	75–79	125,358,156	137,909,337	170,243,306	208,556,711	232,519,470
	80–84	92,537,419	103,525,418	117,836,103	149,126,800	185,486,157
	85 and over	72,893,843	87,322,146	105,562,524	128,329,965	165,018,122
Model 1 No PTD Criteria: M3	70–74	223,707,467	270,993,826	328,253,309	362,127,537	405,974,889
	75–79	176,330,327	195,111,072	241,889,039	296,840,107	331,097,577
	80–84	119,483,924	134,547,800	153,720,005	195,659,205	244,445,621
	85 and over	88,748,795	106,590,048	129,310,959	157,978,955	205,403,140
Model 2 PTD Criteria: M3	70–74	147,312,355	177,384,333	213,906,317	235,376,573	263,265,949
	75–79	125,358,156	137,909,337	169,764,951	207,241,235	230,486,462
	80–84	92,537,419	103,525,418	117,455,954	148,239,785	184,092,275
	85 and over	72,893,843	87,322,146	105,336,171	127,764,082	164,112,710

Table A9
Expenditure projections using predicted expenditure from Two part regression model

Model	Age (years)	2011 (€)	2016 (€)	2021 (€)	2026 (€)	2031 (€)
Including PTD Criteria: M3	70–74	137,330,391	165,285,371	199,245,203	219,198,014	245,124,408
	75–79	117,455,398	129,126,491	158,809,267	193,734,306	215,386,383
	80–84	85,979,187	96,009,895	108,704,042	136,835,963	169,610,825
	85 and over	67,743,424	81,076,455	97,648,300	118,209,443	151,352,219
Excluding PTD Criteria: M3	70–74	214,029,071	259,269,651	314,051,881	346,460,587	388,410,943
	75–79	171,576,202	189,850,591	235,367,354	288,836,861	322,170,699
	80–84	118,633,336	133,589,975	152,625,696	194,266,337	242,705,450
	85 and over	86,235,173	103,571,110	125,648,499	153,504,534	199,585,529

Table A10
Ratio of Non PTD/ PTD (model 1 /model 2) expenditures

Model	Age (years)	2011	2016	2021	2026	2031
Model 1/2	70–74	1.52	1.53	1.53	1.54	1.73
Criteria: M1	75–79	1.41	1.41	1.43	1.43	1.59
Ratio: PTD/no PTD	80–84	1.29	1.30	1.31	1.32	1.61
	85 and over	1.22	1.22	1.23	1.24	1.42
Model 1/2	70–74	1.52	1.53	1.53	1.54	1.54
Criteria: M2	75–79	1.41	1.41	1.42	1.43	1.44
Ratio: PTD/no PTD	80–84	1.29	1.30	1.31	1.32	1.33
	85 and over	1.22	1.22	1.23	1.24	1.25
Model 1/2	70–74	1.52	1.53	1.53	1.54	1.54
Criteria: M3	75–79	1.41	1.41	1.42	1.43	1.44
Ratio: PTD/no PTD	80–84	1.29	1.30	1.31	1.32	1.33
	85 and over	1.22	1.22	1.23	1.24	1.25
Predicted values from Two-part regression model	70 - 74 years	1.56	1.57	1.58	1.58	1.58
	75 - 79 years	1.46	1.47	1.48	1.49	1.50
Criteria: M3	80 - 84 years	1.38	1.39	1.40	1.42	1.43
Ratio: PTD/no PTD	85 years and over	1.27	1.28	1.29	1.30	1.32

Table A11
Central Statistics Office (CSO) Population Projection Model Criteria

Model criteria	Description	Details
M1	Immigration continuing to decline but returning at a high level.	−19,100 per annum in 2011/2016 +18,200 per annum in 2016/2021 +30,000 per annum in 2021/2026 +30,000 per annum in 2026/2031 +30,000 per annum in 2031/2036
M2	Immigration decreasing but returning at more moderate levels.	−21,600 per annum in 2011/2016 +4700 per annum in 2016/2021 +10,000 per annum in 2021/2026 +10,000 per annum in 2026/2031 +10,000 per annum in 2031/2036
M3	Immigration, remaining negative but improving.	−25,100 per annum in 2011/2016 −10,000 per annum in 2016/2021 −5000 per annum in 2021/2026 −5000 per annum in 2026/2031 −5000 per annum in 2031/2036

More detail available at www.cso.ie.

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